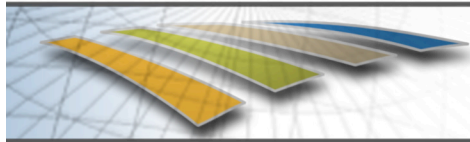


Mission Operations Concept and MOE Overview

Steve Coyle
NASA Mission Operations Manager

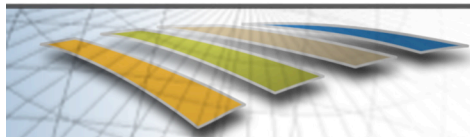


Outline

LDCM

- ♦ Mission Overview
- ♦ Operations Concept
- ♦ MOE Overview
- ♦ Flight Operations





LDCM Mission Overview

LDCM

Launch Date: July 2011

Mission Duration: 5 yrs (10 yr Goal)

Orbit: 705 km circular, sun synchronous (16 day repeat)

Launch Vehicle: TBA

Launch Site: VAFB (Lompoc, CA)

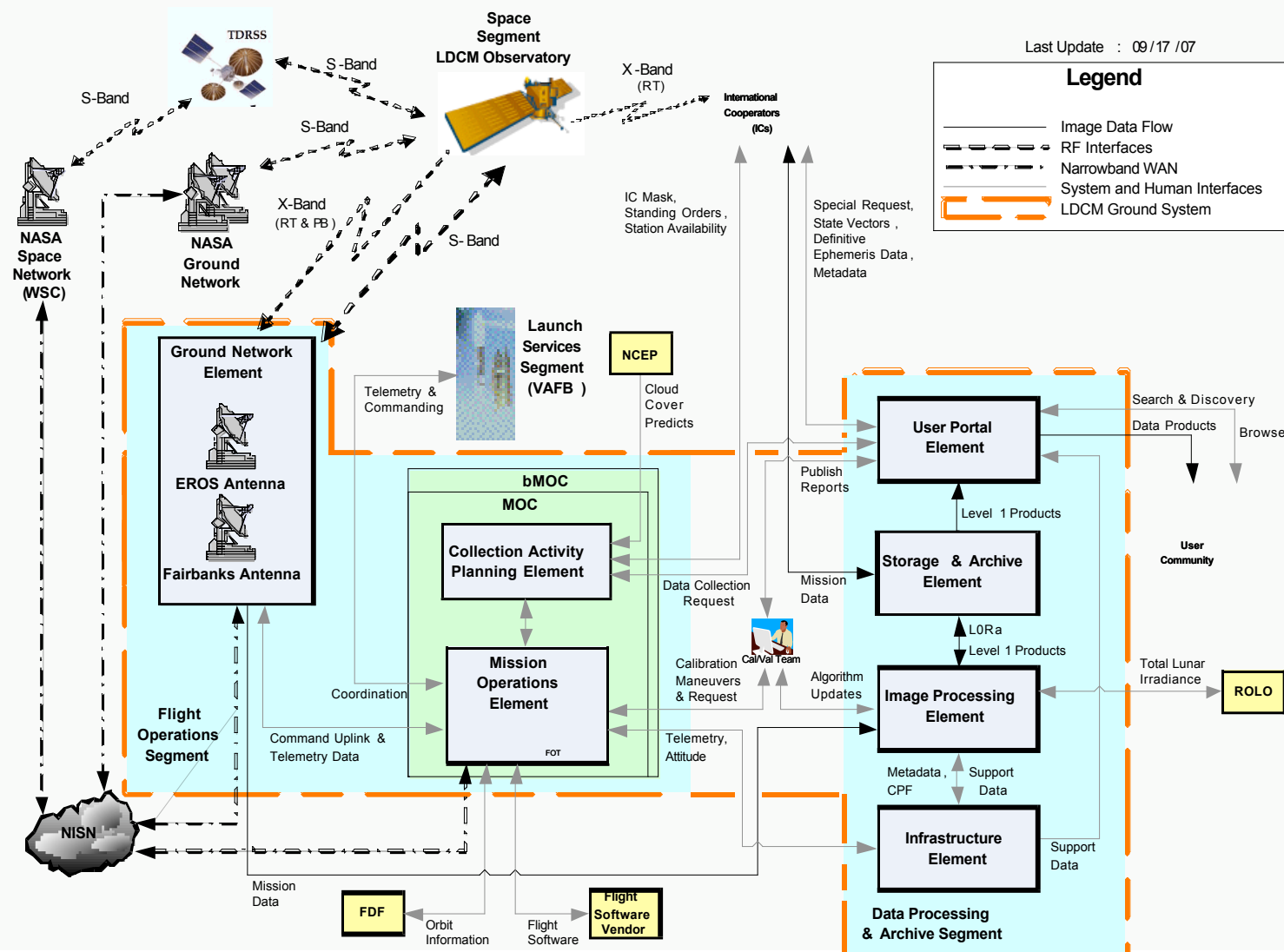
GS Sites: LGN at Fairbanks, AK and Sioux Falls, SD
NASA GN during launch and early orbit,
International Cooperators as users

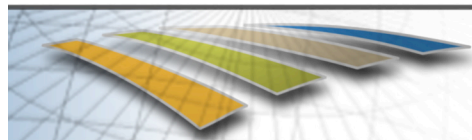
TDRSS (SN): S-Band during launch, early orbit, and
anomaly support



LDCM GS Architecture

LDCM





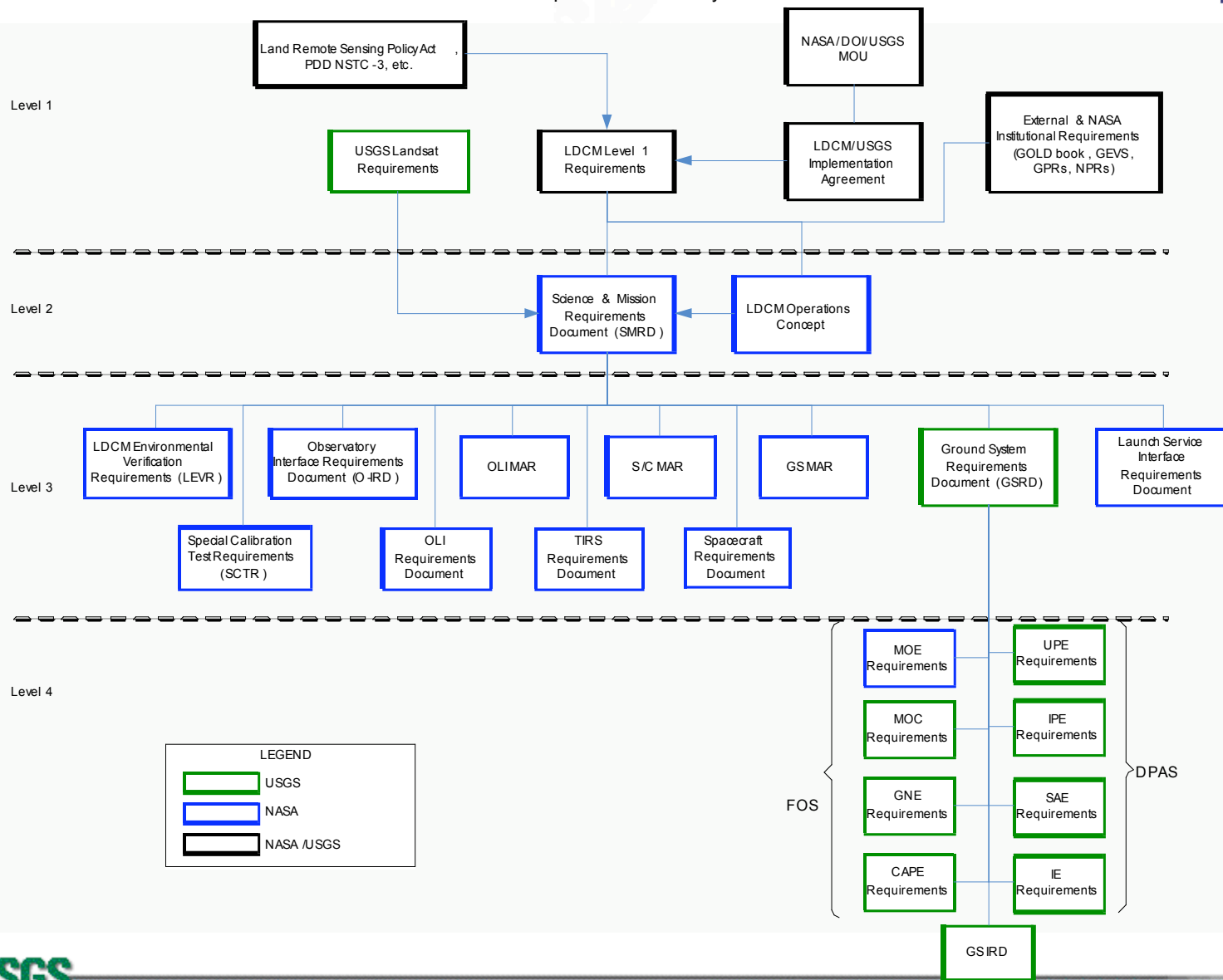
Mission Segments

LDCM

- ◆ **Launch Segment**
 - Provides launch site services and launches the LDCM Observatory to low Earth orbit
- ◆ **Space Segment**
 - LDCM Observatory (Spacecraft + OLI) collects, stores, and transmits LDCM science data
- ◆ **FOS**
 - Performs all mission operations functions
 - Receives science data from observatory
 - Sends/receives observatory commands and telemetry
 - Develops imaging and calibration activities
- ◆ **DPAS**
 - Ingest, processes, archives, and distributes LDCM data and data products
- ◆ **International Cooperators**
 - Special set of customers who receive real-time, direct downlink of science data per USGS partnership agreements and Level 1 requirement

LDCM Requirements Hierarchy

LDCM

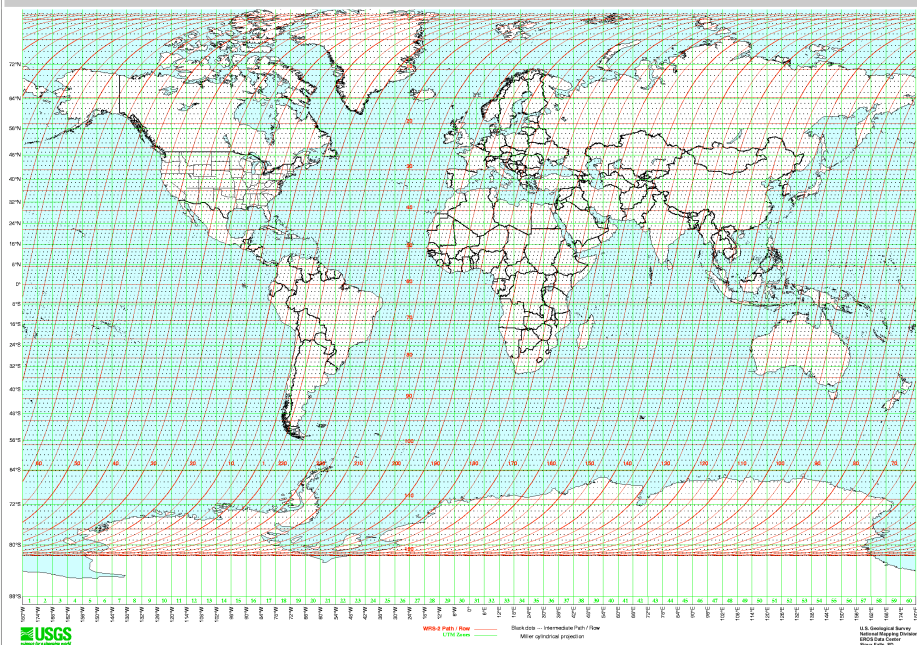


LDCM WRS-2 Operational Orbit

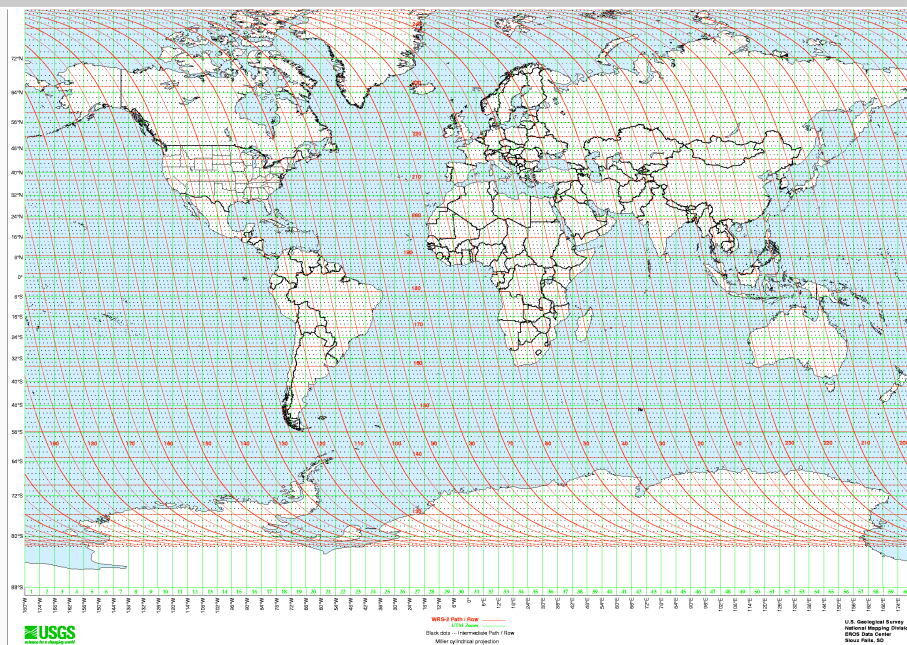
LDCM

Sun-synchronous, near-circular frozen orbit:

| | |
|------------------------------------|---|
| Altitude | 705 Km |
| Inclination | 98.2 degrees |
| Repeat Cycle | 16 days |
| Mean local time of descending node | 10:00 a.m. +/- 15 minutes |
| Ground track error | +/- 5 Km cross track at descending node |



WRS-2 Descending Day Passes



WRS-2 Ascending Night Passes



Landsat Ground Network

LDCM

- ◆ LGN is operational ground network
 - Dedicated stations
 - X-band science data downlink
 - S-band commanding and HK telemetry
- ◆ SN and GN during L&EO and contingencies
 - S-band only
- ◆ CCSDS AOS compliant

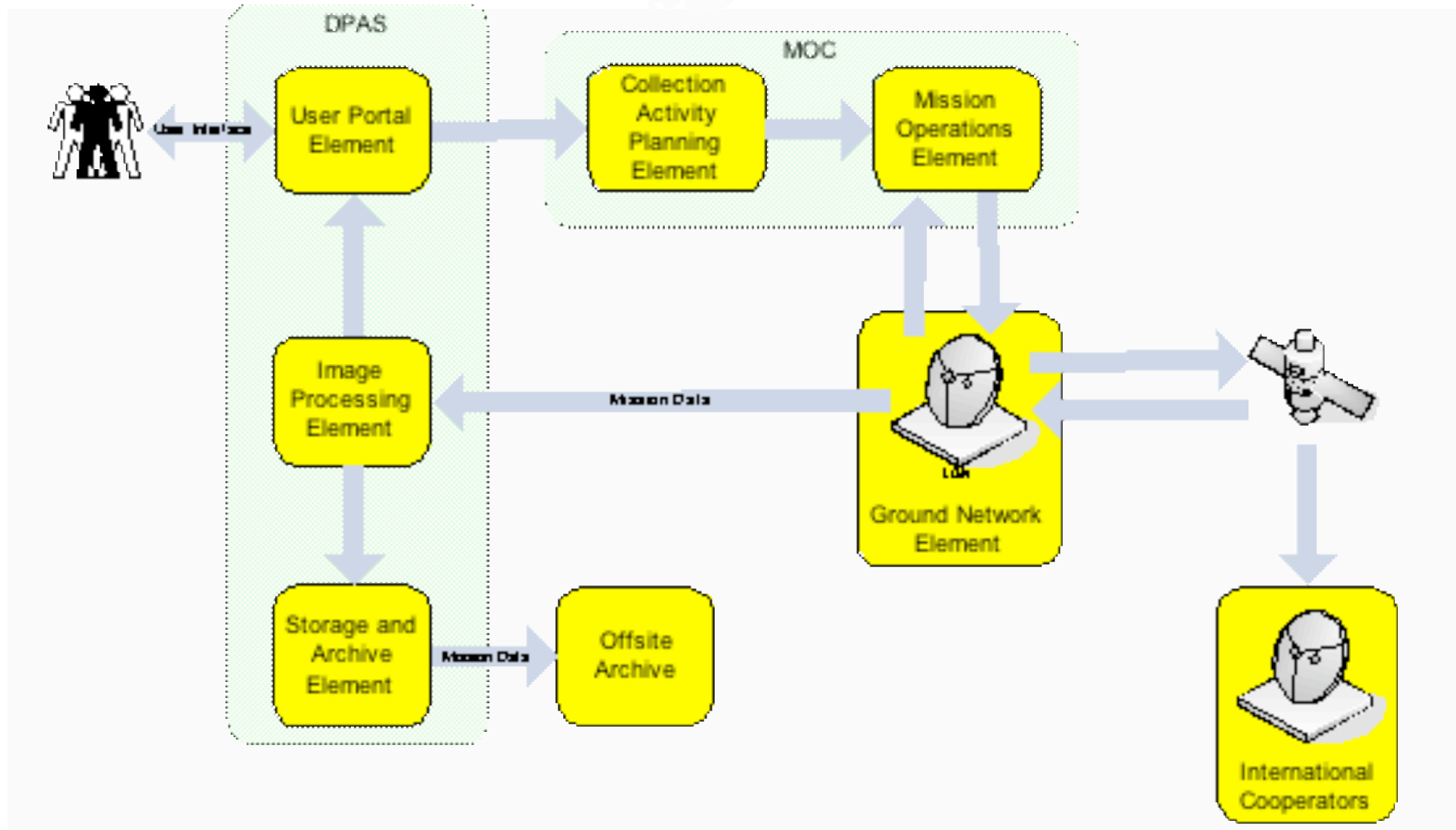


For 5 degree station masks, 90 second minimum contact duration

| Station | Passes Per Day | Longest Gap | Average Duration | Maximum Duration |
|-------------|----------------|-------------|------------------|------------------|
| FAIRBANKS | 10 | 9h 58m | 9.5 min | 12 min |
| SIOUX FALLS | 5 | 11h 47m | 8.6 min | 11 min |
| COMBINED | 15 | 6h 47m | 9.1 min | 12 min |



High Level Data Flow

LDCM



Mission Planning

LDCM

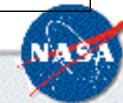
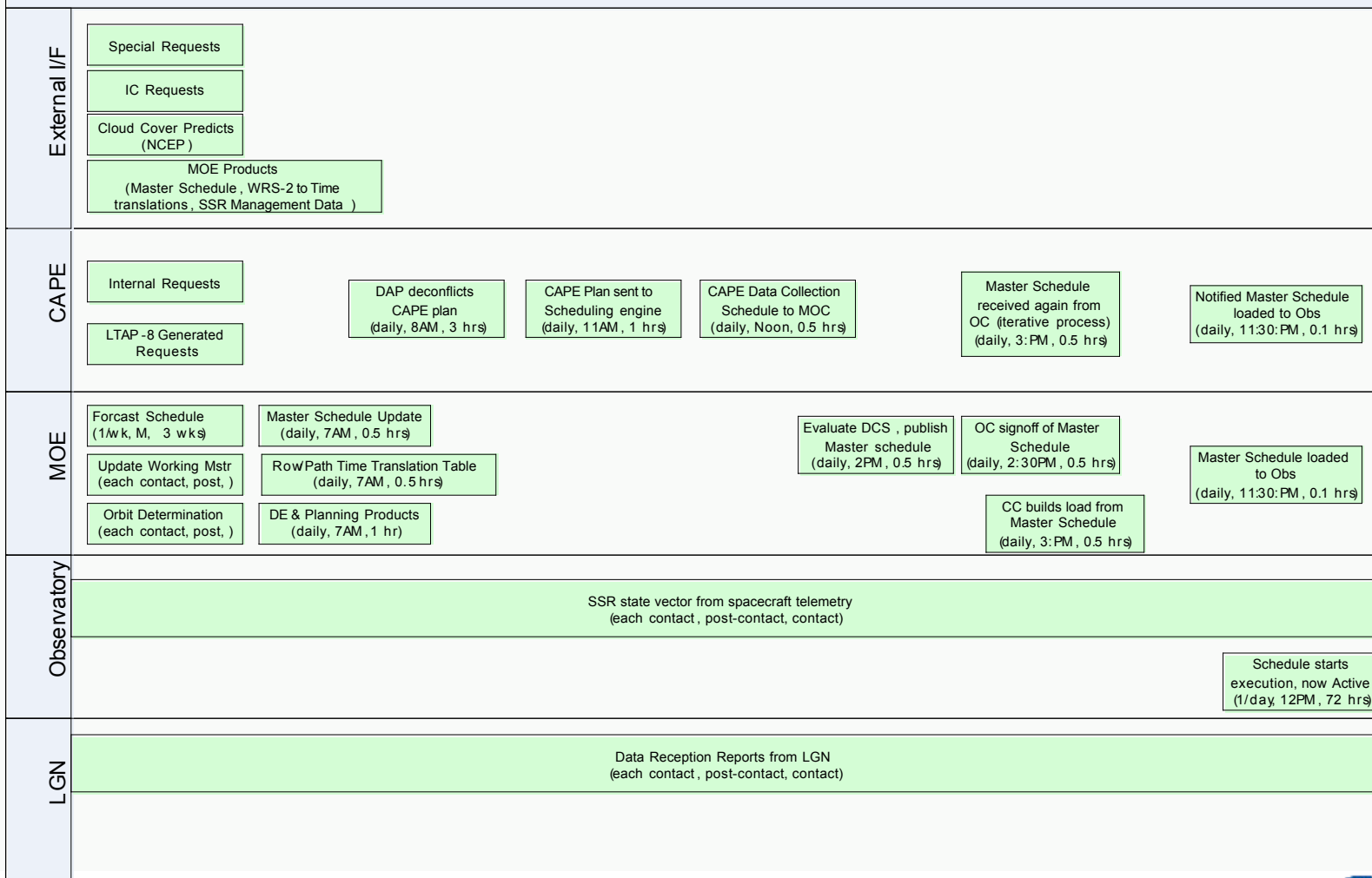
- ◆ Global acquisition science requirements, captured via LTAP-8, are the primary drivers for image collections
 - Additional image collections to support:
 - IC requests (for real-time downlink)
 - Cal/Val requests
 - Special requests (including priority scenes)
- ◆ Resulting output is a de-conflicted image data collection schedule sent from CAPE to MOE
- ◆ MOE plans & schedules all space and ground activities
 - Builds stored command loads (absolute and relative time sequences)
 - Executable pass plans including real/time spacecraft commands and ground system directives

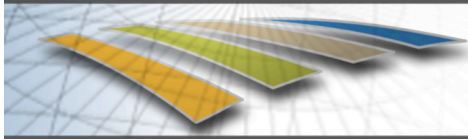
Daily Mission Planning Timeline

LDCM

CAPE / MOE Planning & Execution Overview

CST

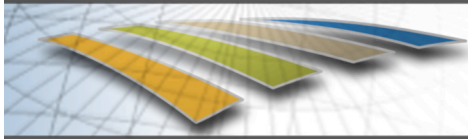




Science Data Return

LDCM

- ◆ Real-time and playback downlinks to dedicated LGN stations
- ◆ Real-time only downlink to ICs based upon scheduled requests
 - “Fire and forget”
 - All scenes downlinked to ICs are also retained on the SSR and returned to EROS via the LGN stations
- ◆ LGN stations transfer science data to DPAS via WAN
- ◆ DPAS archives mission data, generates L1T products and makes them available to the public for download

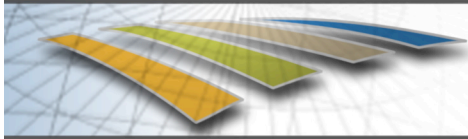


Priority Data Acquisition

LDCM

- ◆ LDCM provides a priority capability to interrupt the nominal imaging cycle
 - Supports Emergency Responders and other Authorized Users (e.g. tsunami, hurricanes)
 - May collect up to 5 priority scenes per day, including off-nadir (+/- 1 WRS-2 path)
 - However, priority does not always imply off-nadir
 - Also includes an expedited production capability for scenes that already exist in the archive

- ◆ **Not a frequent event**
 - L5 & 7 experience 3-5 sequences (collections over multiple orbits) of priority requests per year
 - Impacts of priority imaging on operations are dependent on 16-day repeat and off-nadir acquisition



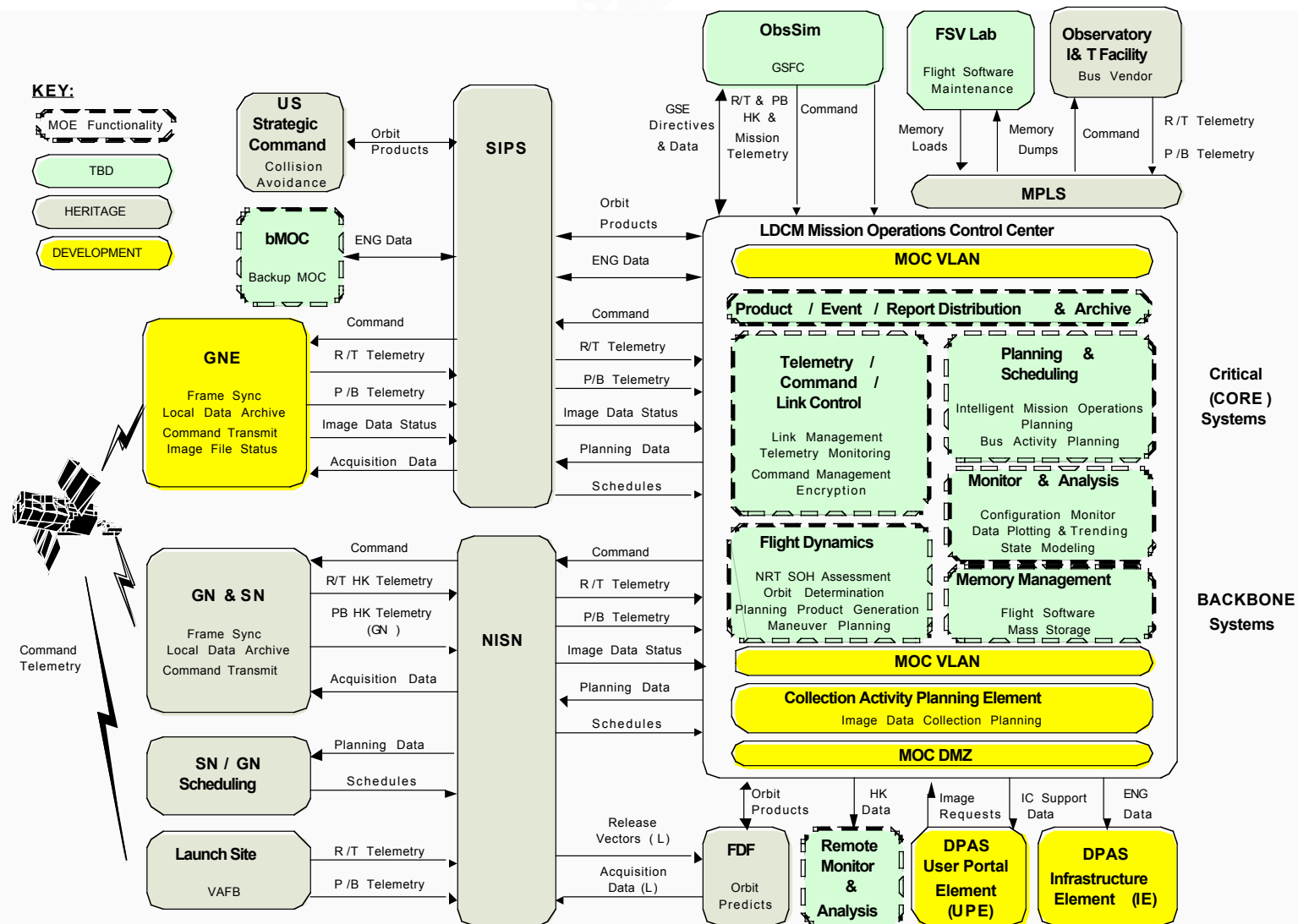
Overview of MOE Services

LDCM

- ◆ The MOE to perform planning & scheduling, command & telemetry processing, mission monitoring & analysis, flight dynamics support, memory management, product generation & distribution, and automated execution of functions supporting the observatory.
 - Interface with LGN, GN and SN assets
 - Process, analyze & archive all S-band data received
 - Assess and maintain the health & safety of the observatory
 - Perform command authorization, management & constraint checking
 - Provide an activity plan using database-defined event priority assignments and activity details
 - Manage data recovery from the Solid State Recorder (SSR)
 - Provide flight dynamics support, including maneuver planning
 - Operate autonomously for at least 72 hour periods

MOE Services Architecture

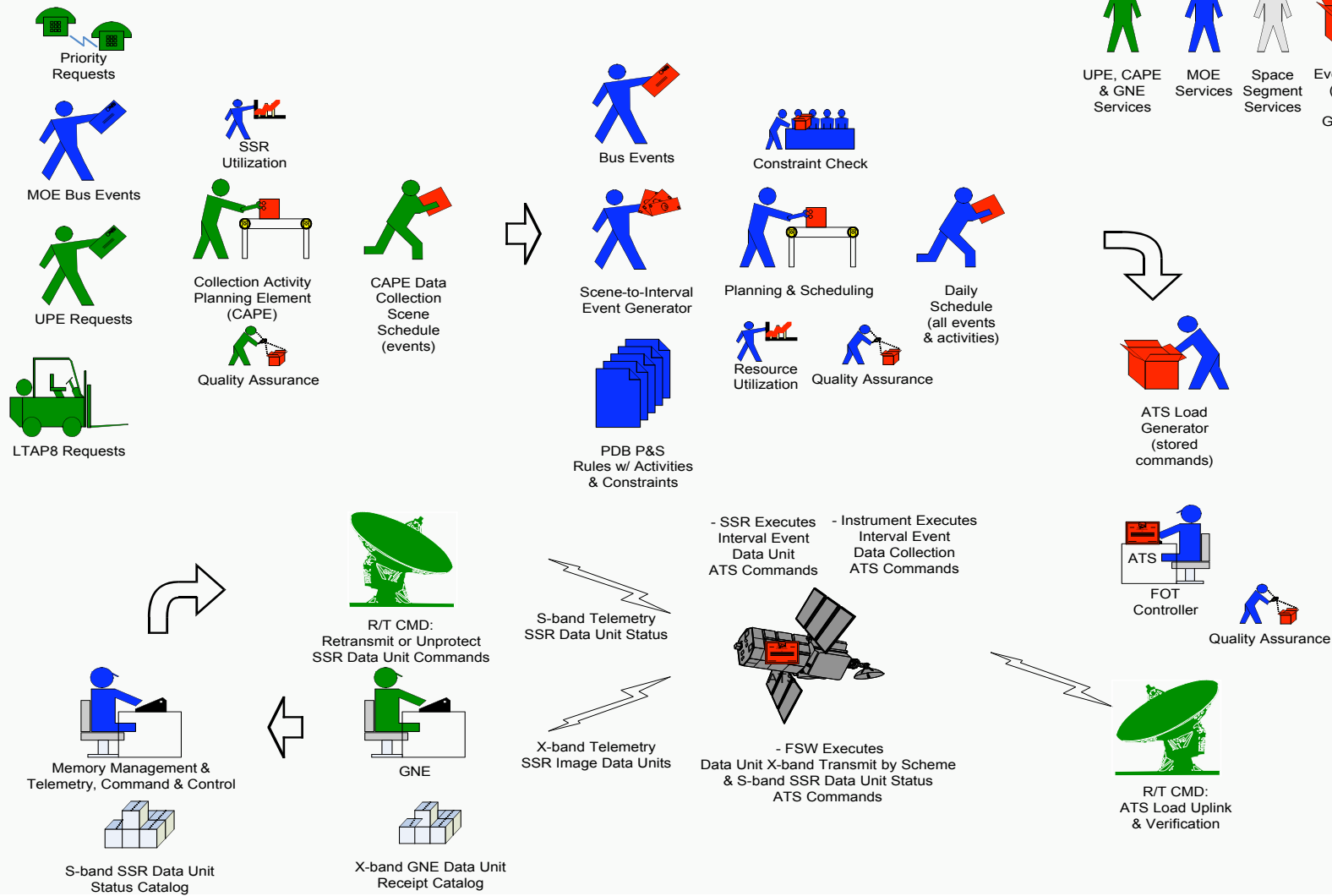
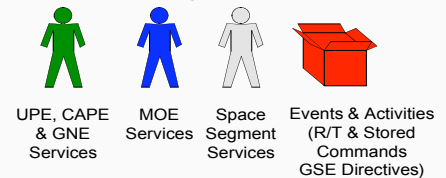
LDCM

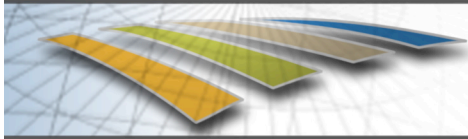


MOE Image Data Collection & Recovery

LDCM

Character Key:





Flight Operations Assignments

LDCM

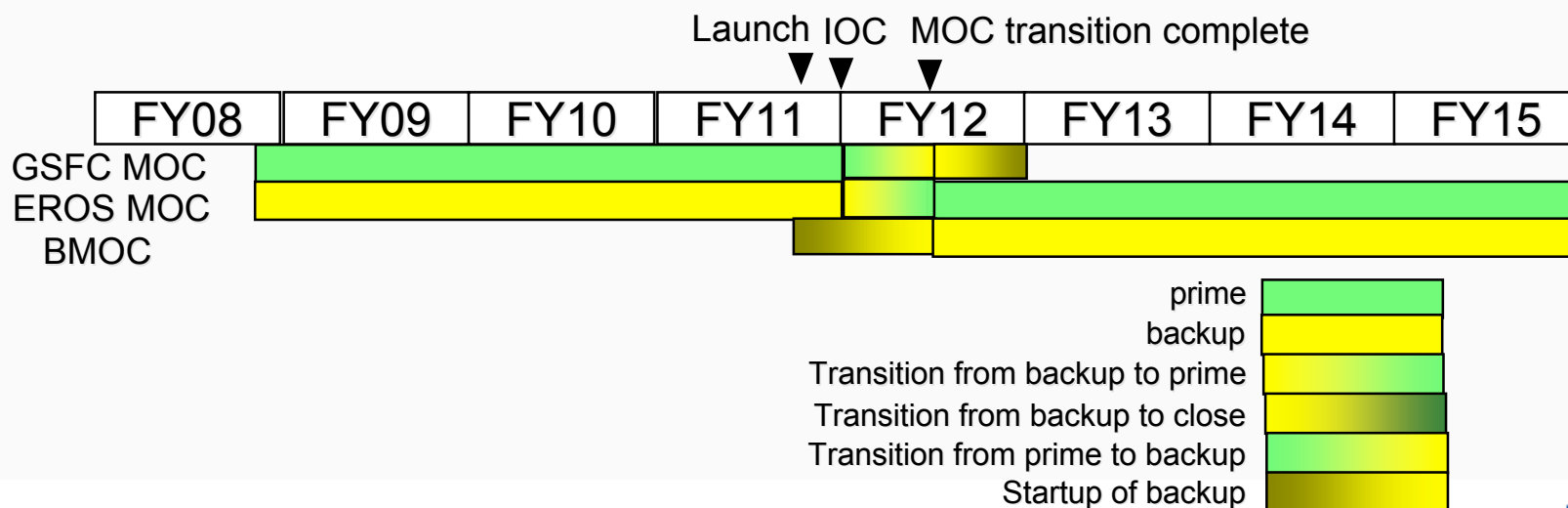
- ◆ USGS provides Flight Operations Team (FOT) during all mission phases.
- ◆ Mission Operations Management
 - NASA performs this function through on-orbit acceptance.
 - USGS performs this function following on-orbit acceptance through the life of the mission
- ◆ NASA & USGS jointly develop an Operations Transition Plan
 - Have begun discussion as input to MOE and FOT SOWs
 - USGS leads move of primary mission ops from GSFC MOC to EROS MOC and standup of TBD-location bMOC
 - Phased move with completion and automation planned for L+9-12 months



Flight Operations Assignments (cont.)

LDCM

- ◆ GSFC Mission Operations Center (MOC)
 - Acts as primary MOC until end of commissioning; then acts as backup MOC temporarily.
- ◆ EROS Mission Operations Center (MOC)
 - Acts as backup MOC until end of commissioning, then as primary MOC.
- ◆ Backup Mission Operations Center (bMOC)
 - Acts as backup MOC after GSFC MOC is decommissioned.
 - Location: TBD



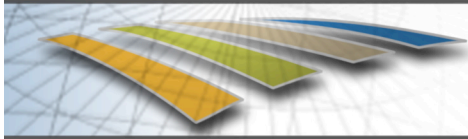


Flight Operations

LDCM

- ◆ MOC operations projected to be highly automated by L+ 1 year
 - Supports 72 hour autonomous operations requirement
 - Phase from 24 X 7 staffing to 8x5 M-F staffing
 - Rate of transition to automation determined by demonstrated capability
 - Routine and most periodic operations performed autonomously

- ◆ Staffed shift supports mission planning and engineering analysis
 - Image activity planning and scheduling (CAPE operations)
 - Routine upload of a 72 hour acquisition schedule (ATS loads)
 - Contingency and Special events, as required
 - Maneuvers (delta I and delta V, solar/lunar calibration)
 - Spacecraft and instrument FSW maintenance
 - MOC maintenance (PRD, software, or hardware)



Project Reference Database (PRD)

LDCM

- ◆ Contains all configuration managed ground system databases
 - Command, telemetry, derived telemetry, procedures, displays, flight software tables and data, etc
- ◆ Managed by an XML-based XTCE System developed by JWST
- ◆ Database works the same in a central or distributed (sandbox)
 - Resident in a central location accessible to the MOC and bMOC
 - Rapid database information ingest, tracking and output in application defined subset
 - Performs compliance checks on ingest
 - All systems use the central database for all system testing environment
- ◆ Databases are under FOT configuration control
 - follow project standard certification processes
 - Maintains a modification history
- ◆ PRD (or derivatives) are available upon request